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FINAL
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
COMPLETION WORK PLAN
BLUFF ROAD SITE
COLUMBIA, SOUTH CAROLINA

Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Waste Programs Enforcement
Washington, D.C. 20460

Work Assignment No.	:	353
EPA Region	:	IV
Site No.	:	
Date Prepared	:	July 15, 1987
Contract No.	:	68-01-7331
CDM Federal Programs		
Corporation Document No.	:	T353-C04-FR-AVWH-2
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1.0 INTRODUCTION

Versar Inc. received a work assignment to develop a work plan for the completion of the Bluff Road Site Remedial Investigation/Feasibility Study (RI/FS). In addition to preparing a work plan to complete the RI/FS, Versar will also prepare a sampling plan, health and safety plan, and data management plan to be utilized during completion of the RI/FS.

Guidance for the review and completion of the RI/FS work plan was provided by the following:

1) Guidance on Remedial Investigations under CERCLA (June 1985);

2) Guidance on Feasibility Studies under CERCLA (June 1985);

3) The National Oil and Hazardous Substances Contingency Plan (NCP);

4) The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA); and

5) Engineering Support Branch, Standard Operating Procedures and Quality Assurance Manual, U.S. EPA, Region IV, April 1986.

The following work plan specifies the tasks needed to complete the RI/FS at the Bluff Road Site. These tasks detail the format of the RI report and the technical issues which need to be addressed. It should be noted that at the time the RI was initiated, no finalized guidance on the completion of RI/FS studies existed.

1.1 Site Background

The Bluff Road Site is located approximately 10 miles southeast of Columbia, South Carolina in Richland County (Figure 1). From 1976 to 1982 the site was operated by South Carolina Recycling and Disposal, Inc. (SCRDI) as a storage, recycling, an disposal facility for waste chemicals. An acetylene manufacturing facility was located on the property prior to its use as a waste facility.

In March 1980, a site inspection by U.S. EPA revealed containers leaking chemicals into drainage ditches and into an on-site surface impoundment (previously used by the acetylene manufacturer). Analysis of the drainage ditch sediments, revealed the presence of organics, pesticides, and metals.

South Carolina Department of Health and Environmental Control (SCDHEC) conducted groundwater investigations at the site in 1980 and 1981. The groundwater investigations documented an increase in levels of organic contaminants at the site during that span of time.

In 1982 and 1983, the preliminary clean-up of the site was performed by U.S. EPA. Drums of chemicals and contaminated soil were removed. However, the on-site lagoon, an above ground tank (Figure 2), and material next to the on-site lagoon (reported to be lime from the acetylene manufacturing operation) were left on site. Under the direction of the SCDHEC, the RI for the Bluff Road Site was initiated by Golder Associates in November 1984. The RI was completed in a phased manner. The phases encompassed the following tasks:

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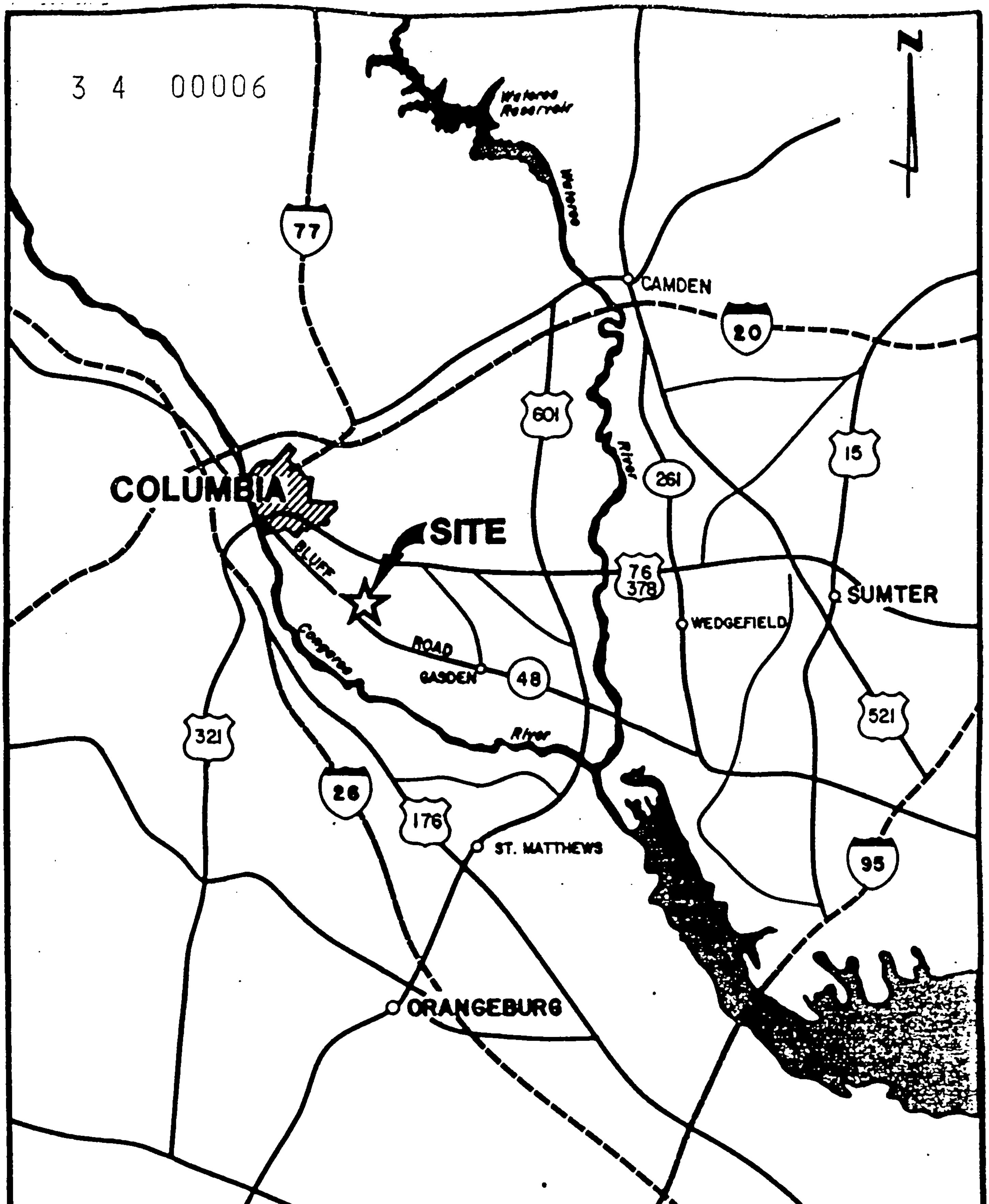

JOB NO. 853-3079	SCALE N.T.S	SITE LOCATION MAP
DRAWN T.s.R.	DATE 1/22/86	
CHECKED MTF	DWG. NO. 15	
		SCDHEC/BLUFF RD./S.C. FIGURE 1

FIGURE 1
BLUFF ROAD SITE LOCATION MAP

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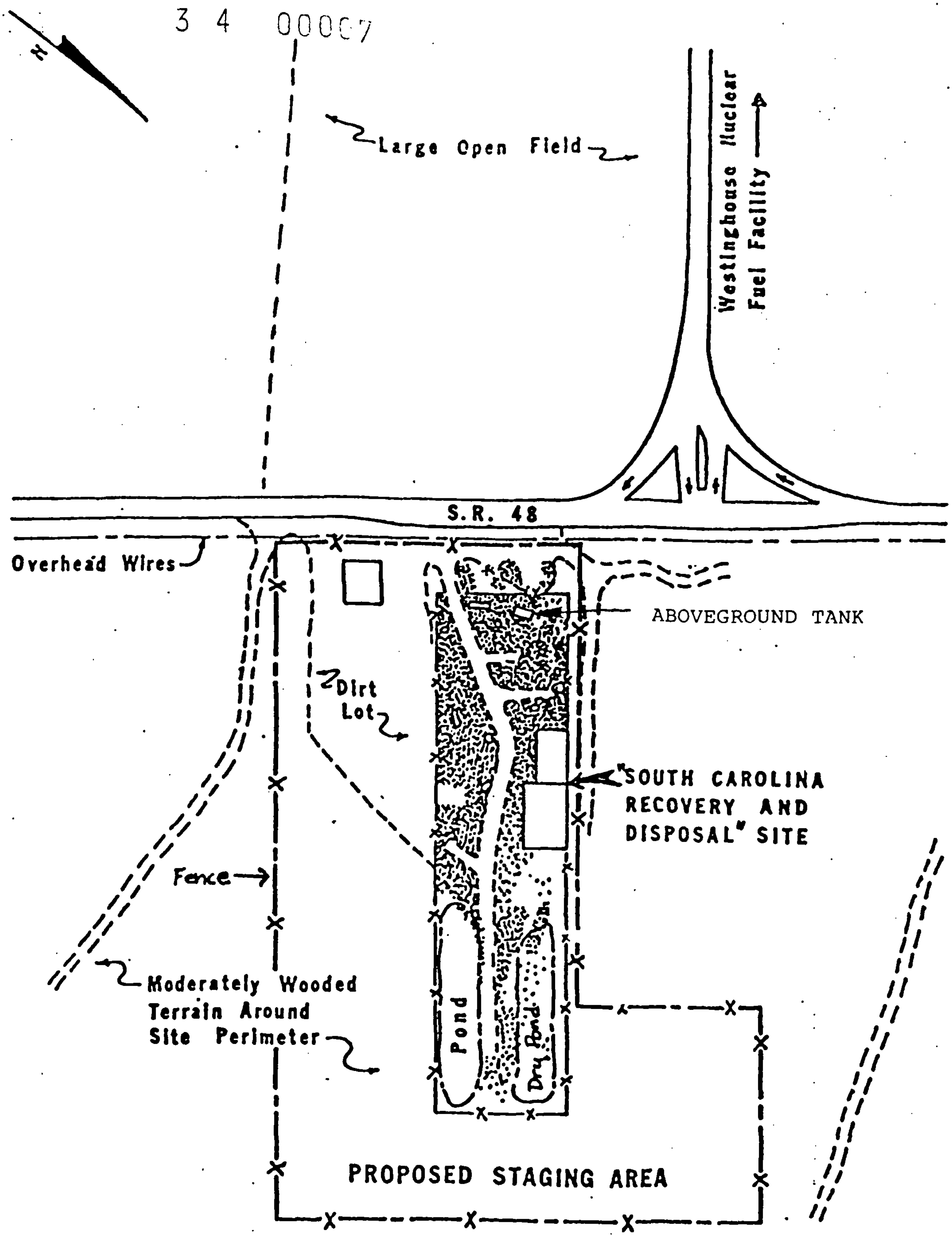

FIGURE 2

SITE LAYOUT.

Not To Scale

1) Background data collection;

2) Collection of soil, lagoon, and sludge samples;

3) Geophysical survey;

4) Installation and sampling of ground-water monitoring wells (Figure 3). This program is referred to in the RI as the Initial Well Program. Also, a soil gas survey was conducted to determine the extent of volatile organic contamination; and

5) Installation and sampling of groundwater monitoring wells. This program is referred to in the RI as the Second Well Program. A pump test was also conducted as part of this program to determine the hydraulic conductivity of the uppermost aquifer. Water collected during the pump test was aerated in an attempt to remove volatile organics from the contaminated ground water. This activity was completed in January 1986.

Golder Associates submitted the current draft of the RI report to U.S. EPA in April 1986. At that time, no work had been performed on the FS portion of the RI/FS. Upon preliminary examination of the RI report, U.S. EPA found that data gaps may exist in the RI; therefore, additional site characterization work needs to be performed.

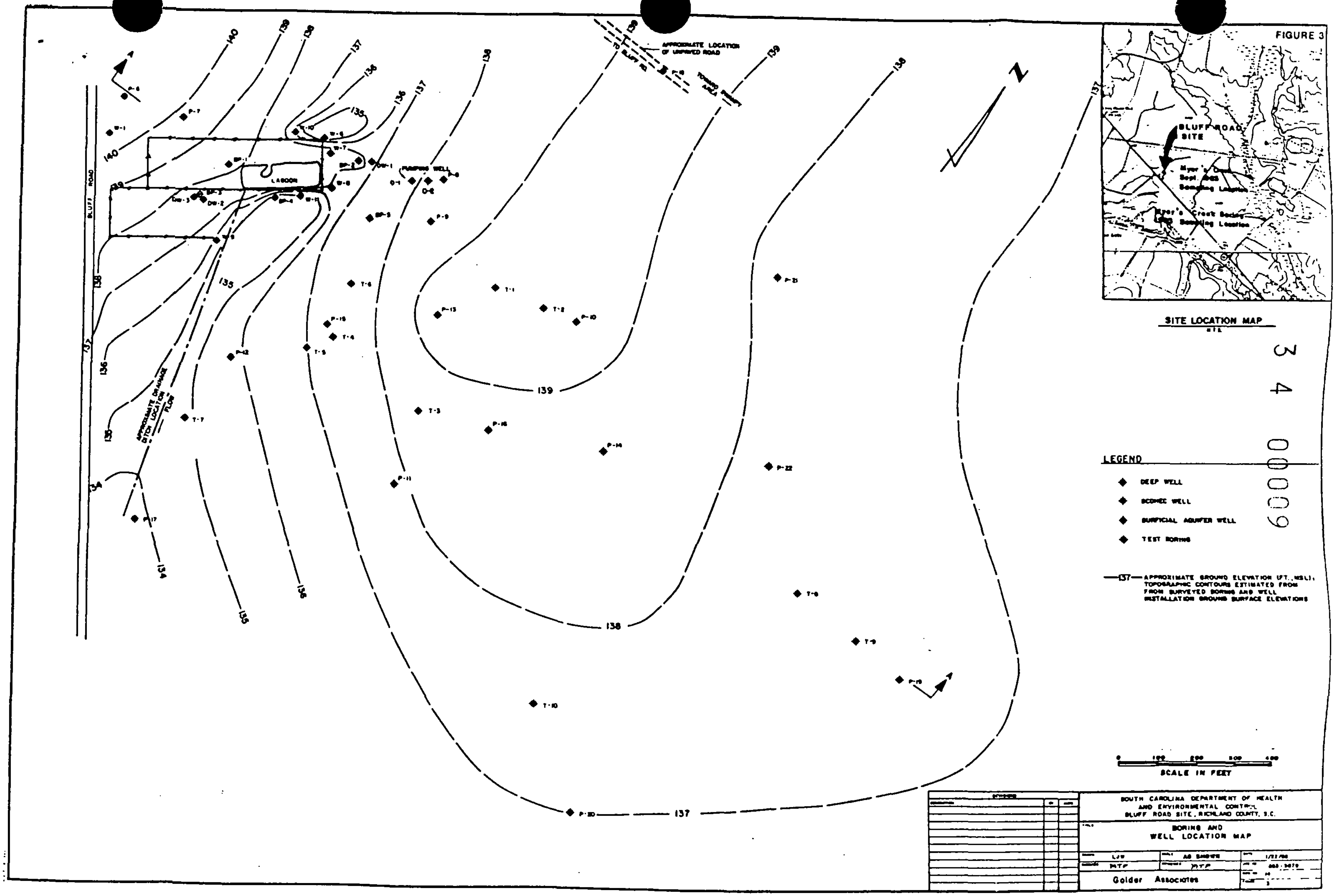

FIGURE 3
EXISTING MONITORING WELL AND SOIL BORING LOCATIONS

2.0 COMPLETION OF THE REMEDIAL INVESTIGATION

In order to complete the RI for the site, the following items should be incorporated into the RI report.

2.1 Develop Executive Summary

An Executive Summary needs to be incorporated into the Bluff Road RI/FS report. This summary should be placed immediately prior to Section 1.0 (Introduction) and should provide a brief overview of the remedial investigation as well as the data collected by the investigation. Key information about the Bluff Road Site and major investigation findings should be summarized in such a manner that the reader is presented with a general understanding of the site and its associated problems.

Five major topics which should be presented in the Executive Summary are:

1) Purpose of the remedial investigation;

2) Site description, background, and problems;

3) Direction and activities of each investigation phase;

4) Major findings; and

5) Data problems and unresolved data needs.

Collectively, the specific elements addressed under each of the above major areas should convey the important characteristics and findings of the RI/FS. Tables and figures should be used where possible to summarize information clearly and concisely.

2.2 Expand Introductory Material

In order to present sufficient background information on the key features, conditions, and parameters of the Bluff Road Site, the introductory material (Section 1.0) should be expanded to include the following information if available:

1) A clear definition or illustration of the Bluff Road Site boundary in relation to the SCRDI facility property, if the two boundaries do not coincide;

2) The location, size, and configuration of facility structures prior to site clean-up (e.g., Campbell's Garage);

3) The location, size, and configuration of facility structures remaining on-site after clean-up (e.g., above-ground tank);

4) A timeframe of on-site waste related activities that is geared towards establishing:
   - initial date of chemical storage,
   - estimates of chemical storage inventory, and
   - completion date of site clean-up;

5) A historical description of:
   - activities and operations,
   - waste types,
   - condition of wastes,

- incidents (fire, explosion, ground-water contamination, etc.),
- site investigations, sampling, regulatory violations, response actions, and enforcement activities,
- ownership,
- past responsible party involvement, and
- all known potentially responsible parties (possibly included as an attachment);

6) Physiography;

7) If applicable, information on the following:
- community perception,
- planned use of site, and
- conflicting or missing information;

8) A site map depicting nearby water supplies, sensitive environmental areas, populations, topography, drainage patterns, and all potentially impacted surface waters; and

9) A description of water use classifications, applicable state water quality standards, and applicable EPA ambient water quality criteria.

2.2.1 Summarize Nature and Extent of Problem(s)

A discussion of the nature and extent of environmental problems at the site should be incorporated into the introductory section of the RI/FS. This discussion should concentrate on the types of materials that have been stored at the site as well as the current contamination problems. This discussion should serve as a framework for assessing the remedial action objectives and for selecting appropriate remedial action alternatives. Existing and potential on-site and off-site contamination problems and effects should be addressed within this section and include:

1) Type, physical state, and quantity of hazardous wastes that have been stored on-site;

2) Special waste considerations (acute toxicity, reactivity, etc.);

3) Current condition and location of materials and structures (e.g., above ground tank and possible underground tank);

4) Changes in site (e.g., possible closed sludge lagoon);

5) Effects of contaminants from the site including:
   - types of contaminant releases, and
   - affected media, movement of contaminants, direction of movement;

6) Resources, populations, or environments threatened or harmed by contaminant movement:
   - human exposure,
   - water quality in receiving streams,
   - sediment concentrations, and
   - projected effect on biota in the streams and wetlands;

7) Immediate impact of site conditions and contaminant migration (subsurface, surface, and atmospheric); and

8) Actions previously taken to mitigate problems and the results of these actions.

Each of the above discussions should be oriented towards presenting a description of the threat, or potential threat, to public health, welfare, or the environment as posed by the site contamination. This discussion should include the extent to which applicable or relevant and appropriate federal or state requirements and public health advisories will be utilized to develop the remedy. Additionally, this section should also provide a description of the adjacent Westinghouse Nuclear Fuel Processing facility, particularly if any environmental problems at the facility could impact the RI/FS.

2.2.2 Develop Report Overview

Following the above referenced information, the RI/FS should include an overview of the remaining information within the report. Accordingly, this section should serve as an introduction to the contents of subsequent chapters.

2.3 Conduct Site Features Investigation

A site features investigation should be conducted for the area surrounding the Bluff Road facility. This investigation should include detailed information on the following subjects:

1) Demography (e.g., size, growth, density, and distribution of human population near the site);

2) Land use (e.g., agricultural, residential, recreational, industrial, etc.);

3) Natural resources (e.g., minerals, timber, soil, wildlife, endangered species, water, national or state forests);

4) Climatology (e.g., average yearly precipitation, seasonal maximum and minimum daily temperatures, periods of heavy rainfall, wind patterns, etc.);

5) Surface drainage patterns; and

6) Surface waters and wetlands.

Each of the above sections should include a description of the key parameters that were investigated and analyzed for the site. Each section should also include any information that is pertinent to the technical, public health, and environmental analyses conducted for the feasibility study.

2.4 Conduct Hazardous Substances Investigation

A hazardous substances investigation of the Bluff Road Site needs to be conducted in order to provide information relevant to the following:

1) Selection of a remedial alternative;

2) Design and planning of remedial actions; and

3) Assessing public health and aquatic life and other environmental impacts.

The hazardous substances investigation will focus upon determining the types of wastes previously or presently stored at the site, and the component characteristics and behavior of each waste type.

Information on waste types should address the quantities, location, components, containment, and composition of waste chemicals previously or presently stored on-site. In particular, this information should concentrate upon all waste materials at the site that may have been sources of environmental contamination, presently pose a threat to public health, or may affect a remedial action.

Information on waste component characteristics and behavior should address the following parameters:

1) Toxicity;

2) Bioaccumulation;

3) Metabolism;

4) Environmental transformation; and

5) Mobility.

The RI does include analyses of wastes from the on-site lagoon. However, this characterization consisted of one composite sample of lagoon water and one composite sample of lagoon sediment which were analyzed for priority pollutants. Seven sediment cores were collected from the lagoon, however, only six samples were composited. No explanation was provided for this discrepancy in sample compositing. No analyses were conducted to define the composition of each layer within the lagoon. No samples were collected from the closed lagoon.

Additionally, the holding times of the samples collected for waste characterization are suspect. The completion of the analysis for volatile organics appears to have been completed in 33 days from the time of sample collection. The normal holding time for the completion of this analysis is 14 days.

Each discernible layer of material within the on-site lagoon and closed lagoon will be sampled, and analyzed, to determine the hazardous nature of the material. Appropriate holding times for samples prior to analysis will be maintained.

2.5 Hydrogeologic Study

2.5.1 Define Extent of Clay Aquitard

The lateral and vertical extent of the clay aquitard which comprises the upper Black Mingo Formation will be defined. This task may be accomplished by conducting an additional soil boring program and collecting Shelby tube samples of the clay for intrinsic permeability analysis. The lateral and vertical definition of the clay unit is critical in the direction of ground-water flow (i.e., to the northeast) in the uppermost aquifer.

2.5.2 Determine the Mineralogy of the Clay Unit

Define the mineralogy of the clay aquitard and determine if the clay is being degraded by organic constituents present in the ground water.

The RI report states "The predominant clay mineral in the upper portion is montmorillonite with quartz, opal, calcite, and mica minerals also present". It is known that some clays are attacked by organic compounds, thereby, leading to degradation of the confining unit.

2.5.3 Define Current and Potential Use of Groundwater

The current and potential use of both aquifers at the site must be examined. Points to be considered during this investigation are the numbers of ground-water wells within a two mile radius of the site and the usage of these wells (i.e., private drinking water, public supply, agricultural use, etc.), overall quality of the ground water, the direction of flow in both aquifers, the rate of ground-water flow in both aquifers, and the recharge and discharge areas for each aquifer. This information will be necessary to develop the ground-water classification.

2.5.4 Determine Flow Direction in Lower Aquifer

The direction of ground-water flow in the lower aquifer will be defined. The RI report states that ground-water flow in this unit is thought to be to the south. However, this information was obtained from a report completed at the Westinghouse Electric Corporation Plant and not at the Bluff Road Site. This information is critical to ensure that the lower aquifer has not and will not be contaminated by constituents from the Bluff Road Site. The lower aquifer is an important resource for irrigation and industrial water use.

Deep wells will be located up- and downgradient of the known areas of contamination. These wells should be constructed in such a manner as to prevent interconnection between the surficial and lower aquifer. This construction techniques. A survey by Golder Associates located eight of these wells, however, the remaining three should also be located, if possible, and properly abandoned.

The use of screen lengths in excess of 30 feet will not be continued. In order for well installations to define the extent of the plume or background water quality, screen lengths will be restricted to lengths of ten feet or less. The use of shorter screen lengths will prevent dilution of ground-water samples. Additionally, delineation of zones of contamination, if present, can be accomplished by utilizing wells constructed with shorter screens.

The construction of wells BP-1 and BP-2 is suspect due to the difficulty of developing the polyethylene "well tips". Well construction logs illustrate that the "well tips" were only partially developed. Therefore, sampling from these "well tips" should be discontinued and the use of these wells will be limited to collecting piezometric data.

2.5.7 Ground-water Monitoring

Compositing of ground-water samples, such as that conducted in the September 1985 sampling, will be eliminated. Composite sampling, especially for volatile organic analysis, is not an acceptable method to determine the presence of contaminants in ground water. Therefore, only discrete water samples will be collected.

Ground-water samples collected for metals analyses will be construction will require drilling a large diameter borehole to the clay aquitard, setting and grouting the casing to the land surface, then continuing drilling inside of the large diameter casing down to the desired monitoring zone.

2.5.5 Determine Overall Water Quality

The overall water quality of both aquifer units needs to be determined. Although numerous ground-water samples have been collected from the surficial aquifer at the site, only two of these samples have been subjected to a full priority pollutant scan. Additionally, the upgradient ground-water samples collected from well P-6, a surficial aquifer monitoring well, have had small amounts of organic compounds (<5 ppm) detected in the ground water. Full hazardous substances list scans should be conducted on samples collected from wells located in hydraulically upgradient and downgradient locations to determine overall water quality at the site.

2.5.6 Well Construction

The use of PVC and vyon (polyethylene) materials in the construction of well materials will be eliminated. The utilization of PVC in ground water contaminated with organic compounds may cause leaching of organic constituents from the PVC materials. Alternate materials such as Teflon or stainless steel will be utilized in future well construction.

The monitoring wells (W-1 to W-11) installed by SCDHEC will be located and properly abandoned because of questionable analyzed for total metals (unfiltered samples) as well as the dissolved metals fraction.

2.5.8 Define Extent of Contamination near the Drainage Ditch

The degree of ground-water contamination that has occurred in the vicinity of the drainage ditch (near well P-17) will be determined. Because this area is located outside of the contaminated ground-water plume in the surficial aquifer, the installation of additional monitoring wells will be necessary in the ditch area. Monitoring wells will be installed upgradient of the drainage ditch in order to delineate any source that may be located in the right-of-way with Bluff Road.

2.5.9 Define Extent of Contamination near Well P-18

The occurrence of ground-water contamination in the area of monitoring well P-18 will be investigated. Concentrations of volatile organics (<0.5 ppm) have been detected in this area. This task will also require the installation of ground-water monitoring wells and the collection of ground-water samples to determine the extent of the contamination near well P-18.

2.5.10 Determine the Extent of the Contaminated Ground-water Plume

The extent of the contaminated ground water in the upper aquifer will be defined. The RI report has values of ground-water velocity ranging from 8 to 56 feet per month.

Based upon this data, in the 18 months since the completion of the RI field work, ground water may have moved from 150 to 1000 feet downgradient. In December 1985, well P-19 was found to be clean. At the time the RI was submitted, the expected edge of the plume was estimated to be approximately 100 feet upgradient of well D-19. Therefore, in 18 months the contaminant plume has probably extended downgradient beyond well P-19. Additional sampling of well P-19 will be necessary to determine if the plume of contamination has moved to the point of well P-19. However, all wells which were not properly developed (e.g., P-19, P-20, P-21, P-22) at the time of construction, will be developed prior to sample collection. Ground-water sampling will be conducted by screening selected wells for indicator parameters to determine the course of future sampling or well installation. If this screening proves to be inconclusive, an expanded list of parameters (e.g., VOCs, metals) will be collected for analysis.

If contamination is found in well P-19; additional downgradient monitoring wells will be installed at the Bluff Road site. Ground-water samples will be collected from these newly installed wells and analyzed to determine if the plume has moved beyond the location of the new well(s).

2.5.11 Soil Contamination

The delineation of the extent of soil contamination at this site has been based solely on the volatile organic analysis of 18 soil samples, and a priority pollutant scan of one composite soil sample. These samples were collected in January 1985. The

RI report provides no rationale as to how these 18 samples were chosen for chemical analysis, given that a total of 65 soil samples had been obtained.

Soil sample locations were mainly restricted to the fenced area of the Bluff Road Site. However, six soil samples were collected upgradient of the site. No soil samples were collected downgradient and outside of the fenced area.

The results of the chemical analysis of the 18 soil samples are suspect. Many of the analytical reports were issued in June 1985. However, the samples were collected in January 1985. If this discrepancy in time cannot be explained, the volatile organic analyses of the soil samples may be considered invalid due to inappropriate holding times prior to analysis.

As part of the RI, chemical analyses of soil samples will be performed to determine the lateral and vertical extent of soil contamination.

The previous soil gas survey conducted as part of the RI will be utilized as a starting point to determine the extent of soil contamination. Additional split-spoon soil samples will be collected from zones above the water table and subjected to full hazardous substances list scans. Lithologic logs will be produced for each soil boring location.

2.6 <u>Surface Water Investigation</u>

The surface water medium which was not addressed in the RI report will be defined during the completion of the RI. Nevertheless, SCDHEC conducted a preliminary investigation of the surface water regime in March 1980.

This investigation focused on the drainage ditch which runs through the site, surface run-off, surface spills, and Myers Creek.

A minimum number of samples were obtained in this investigation (i.e., one upgradient and one downgradient sample for each area). Therefore, the overall problem, if any, has not been defined.

The investigation indicated increased concentrations of metals and organics between sampling points located upstream and downstream of the Bluff Road Site in Myers Creek.

In addition, the report documented an intermittent stream which is believed to join Myers Creek. This drainage way originates in an area southeast of the fenced Bluff Road Site and empties into Myers Creek directly above the downstream sampling point utilized during the SCDHEC study.

As part of the activity needed to complete the RI, a series of water and sediment samples will be collected to determine the extent of contamination, if any, in the surface water regime at the Bluff Road Site.

2.6.1 Sampling of Myers Creek

Sampling of Myers Creek will include a series of sediment samples from the creek bed. This sediment sampling will be conducted in upstream and downstream locations to determine the extent of contamination that may have occurred.

Additionally, water samples will be collected from any tributary streams that may drain the Bluff Road Site and empty into Myers Creek. Water samples will also be collected at ground-water discharge points in Myers Creek.

2.6.2 Sampling of the Intermittent Stream

Sediment samples will be collected along the intermittent stream that joins Myers Creek southeast of the Bluff Road Site. This sampling may delineate the contribution of this stream to the contamination found in Myers Creek.

If possible, water samples will also be collected from the intermittent stream.

2.6.3 Sampling of the Drainage Ditch

The drainage ditch, which may empty into the Congaree River, will also be sampled to determine if it may be contributing pollutants off-site. Sampling will consist of sediment and surface water collection.

Additionally, sediment samples will be collected from surface run-off areas documented in the July 1980, SCDHEC report. Of note is the area labeled as RO-2 which contained the highest concentration of metals.

2.7 Conduct Biota Investigation

A biota investigation of the Bluff Road Site and surrounding area should be conducted in order to determine contaminant levels for site flora and fauna. This investigation should provide information on the following areas:

1) Potentially affected ecosystems;

2) Endangered species residing at/or near the site;

3) Critical habitats;

4) Contaminant levels of potential human food sources; and

5) Biocontamination (i.e., bioaccumulation and biomagnification within and across local ecosystems).

It is anticipated that the contaminants found at the Bluff Road Site would not readily bioaccumulate. Therefore, the biota investigation will probably be restricted to Myers Creek and the adjacent wetlands.

2.8 Conduct Air Investigation

An air investigation should be conducted at the Bluff Road Site in order to determine the following information:

1) Types of airborne contaminants;

2) Concentrations of airborne contaminants;

3) Source and mode of release of airborne contaminants;

4) Contaminant plume dimensions;

5) Contaminant plume movement; and

6) Environments or human populations threatened by airborne contaminants.

The information outlined above should be integrated with climatic and weather data to determine potential pathways of contaminant migration.

It should be noted that contaminant migration via the air pathway is not a primary route of exposure. Additionally, this study may have been waived by SCDHEC and therefore not presented in the RI.

2.9 Treatability Study

As part of the RI, treatability studies were conducted on soil and ground-water samples collected at the Bluff Road Site. The specific tests conducted were as follows:

1) Soil leachability study;

2) Volatile Organics Stripping for ground water; and

3) Soil Aeration.

The soil leachability and ground-water stripping studies concluded that volatile organic contamination could be removed utilizing these technologies. The studies also concluded that these methods are viable remedial alternatives at the Bluff Road Site, however, further study was recommended in the FS.

The soil aeration study was not completed due to the curtailment of the project.

A large scale ground-water stripping study was conducted as part of the pumping test. However, the results of this study were inconclusive.

These remediation techniques should be examined further to determine if these, or other technologies, could be implemented as viable remedial solutions to the problem at the Bluff Road Site.

2.10 Environmental Risk Assessment

To complete the RI, there needs to be an assessment of the potential hazard the site poses to the surrounding area. The RI needs to identify potential receptors, the routes by which these receptors may be exposed, and the contaminants of concern to these receptors.

The data that is necessary for the determination of the impact of the site on human populations and environmental systems includes all of the data collected during the RI. This data will be evaluated (e.g., compared to EPA and State water quality standards) to help determine the final remedial action(s) to be utilized at the Bluff Road Site.

In this evaluation the following items should be examined:

1) A description of the types, quantities, physical form, and disposition of hazardous substances; degree of containment, and facility characteristics affecting release;

2) A description of the environmental setting of the facility. This would include the geologic, atmospheric, and hydrogeologic settings. Pathways of migration should be documented as they are known to exist and potential migration pathways should be explained;

3) A description of contaminant concentration levels known to exist on-site and off-site. This information should be presented in the form of analytical data and corresponding illustrations; and

4) A description of the potential and known receptors near the Bluff Road Site.

2.11 Final Remedial Investigation Report

The final RI report will incorporate all items included in this work plan and those comments by EPA and SCDHEC. Table 1 provides the format this report should follow. The report should include all data generated during the site investigation.

TABLE 1
REMEDIAL INVESTIGATION REPORT FORMAT

EXECUTIVE SUMMARY

1.0 INTRODUCTION

- 1.1 SITE BACKGROUND INFORMATION
- 1.2 NATURE AND EXTENT OF PROBLEM(S)
- 1.3 REMEDIAL INVESTIGATION SUMMARY
- 1.4 OVERVIEW OF REPORT

2.0 SITE FEATURES INVESTIGATION

- 2.1 DEMOGRAPHY
- 2.2 LAND USE
- 2.3 NATURAL RESOURCES
- 2.4 CLIMATOLOGY

3.0 HAZARDOUS SUBSTANCES INVESTIGATION

- 3.1 WASTE TYPES
- 3.2 WASTE COMPONENT CHARACTERISTICS AND BEHAVIOR

4.0 HYDROGEOLOGIC INVESTIGATION

- 4.1 SOILS
- 4.2 GEOLOGY
- 4.3 GROUND WATER

5.0 SURFACE-WATER INVESTIGATION

- 5.1 SURFACE WATER
- 5.2 SEDIMENTS
- 5.3 FLOOD POTENTIAL
- 5.4 DRAINAGE

6.0 AIR INVESTIGATION

7.0 BIOTA INVESTIGATION

- 7.1 FLORA
- 7.2 FAUNA

8.0 BENCH AND PILOT TESTS

9.0 PUBLIC HEALTH AND ENVIRONMENTAL RISK ASSESSMENT

- 9.1 POTENTIAL RECEPTORS
- 9.2 PUBLIC HEALTH RISK ASSESSMENT
- 9.3 ENVIRONMENTAL RISK ASSESSMENT

REFERENCES

APPENDICES

3.0 COMPLETION OF THE FEASIBILITY STUDY

The completion of the following tasks will be necessary in order to complete a Feasibility Study for the Bluff Road Site. Golder Associates did not submit a FS as part of the RI report. Therefore, all steps of the FS are yet to be conducted. It should be noted, however, that some treatability studies were conducted as part of the previous RI. All useable information on the results of these studies will be incorporated into the FS.

3.1 Define Site Problem(s)

Based on the results of the RI, define the nature and extent of the problem at the site. This definition needs to include types of contamination at the site, the source of the contamination, migration pathways of concern at the site, and potential receptors at or near the site. Any changes to the original description of the nature and extent of the problem at the site included in the RI Work Plan should be discussed and justified based on results of the remedial investigation.

Following this summary of the current situation, a site-specific statement of purpose for the response, based on the results of the remedial investigation, should be presented. The statement of purpose should identify the actual or potential exposure pathways that should be addressed by remedial alternatives. The statement of purpose should also establish site-specific objectives and criteria for the development and evaluation of alternatives. These objectives shall be based on public health and environmental concerns, information gathered during the remedial investigation, CERCLA as amended by SARA, the National Contingency Plan (NCP) and any amendment thereto, EPA guidance, 40 CFR 264 (RCRA), Federal and State water quality standards including narrative toxicity standards, and the requirements of any other applicable or relevant and appropriate federal or state requirement (ARARS), standard, criteria, limitation, or statutes.

3.2 Preliminary Remedial Technologies

Based on the site-specific problems and statement of purpose identified in response to Section 3.1, develop a specific list of potentially feasible remedial technologies. These remedial technologies will include both on-site and off-site remedies, depending on site problems. The specific list will be developed from a general list by screening technologies based on site conditions, waste characteristics, and technical requirements, to eliminate or modify those technologies that may prove extremely difficult to implement, will require unreasonable time periods, or will rely on insufficiently developed technology.

3.2.1 Identification of General Response Actions

Using the definition of the nature and extent of the problems as a guide, the list of general response actions found in Table 2 will be reviewed and those actions which are applicable to site problems identified.

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TABLE 2

GENERAL RESPONSE ACTION

- No action
- Containment
- Pumping
  - On-site
  - Off-site
- Collection
- Diversion
- Complete removal
- Partial removal
- On-site treatment
- In situ treatment
- Storage
- On-site disposal
- Off-site disposal
- Alternative drinking water supply
- Relocation of receptors
- Other off-site measures

3.2.2 Identification of Specific Remedial Technologies

For each general response action which was identified as being applicable to site problems, the specific remedial technologies associated with it will be reviewed for suitability to remedy site problems. The typical remedial technologies associated with each general response action are listed on Table 3.

A more extensive list of remedial technologies is included in Appendix A. The review should identify specifically to which portion of the site problem each remedial technology is applicable and the degree to which it will mitigate the problem. Also, any site characteristics or waste characteristics that might alter the effectiveness of a remedial technology at the Bluff Road Site should be noted. Table 4 lists some of the site and waste characteristics to be considered.

3.3 Development Of Alternatives

Given the statement of purpose for the response action developed in response to Section 3.1, the applicable remedial technologies identified in response to Section 3.2, will be combined to form remedial action alternatives for the site. These alternatives will address site problems by controlling the source of contaminants, managing the migration of contaminants or both.

TABLE 3
GENERAL RESPONSE ACTIONS AND ASSOCIATED
REMEDIAL TECHNOLOGIES

General Response Action	Technologies
No Action	Some monitoring and analyses may be performed.
Containment	Capping; groundwater containment barrier walls; bulkheads; gas barriers.
Pumping	Groundwater pumping; liquid removal; dredging.
Collection	Sedimentation basins; French drains; gas vents; gas collection systems.
Diversion	Grading; dikes and berms; stream diversion ditches; trenches; terraces and benches; chutes and downpipes; levees; seepage basins.
Complete Removal	Tanks; drums; soils; sediments; liquid wastes; contaminated structures; sewers and water pipes.
Partial Removal	Tanks; drums; soils; sediments; liquid wastes.
On-site Treatment	Incineration; solidification; land treatment; biological, chemical, and physical treatment.
Off-site Treatment	Incineration; biological, chemical, and physical treatment.
In Situ Treatment	Permeable treatment beds; bioreclamation; soil flushing; neutralization; land farming.
Storage	Temporary storage structures.
On-site Disposal	Landfills; land application.
Off-site Disposal	Landfills; surface impoundments; land application.
Alternative Water Supply	Cisterns; aboveground tanks; deeper or upgradient wells; municipal water system; relocation of intake structure; individual treatment devices.
Relocation	Relocate residents temporarily or permanently

TABLE 4

SITE CHARACTERISTICS THAT MAY AFFECT REMEDIAL TECHNOLOGY SELECTION

Site volume	Depth of bedrock
Site area	Depth to aquicludes
Site configuration	Degree of contamination
Disposal methods	Direction and rate of ground water flow
Climate (precipitation, temperature, evaporation)	Receptors
Soil texture and permeability	Drinking water wells
Soil moisture	Surface waters
Slope	Ecological areas
Drainage	Existing land use
Vegetation	Depths of ground water or plume

WASTE CHARACTERISTICS THAT MAY AFFECT REMEDIAL TECHNOLOGY SELECTION

Quantity/concentration	Infectiousness
Chemical composition	Solubility
Acute toxicity	Volatility
Persistence	Density
Biodegradability	Partition coefficient
Radioactivity	Compatibility with other chemicals
Ignitability	Treatability
Reactivity/corrosivity	

To the extent that it is both feasible and appropriate, treatment alternatives for source control actions will be developed ranging from an alternative that would eliminate the need for long-term management (including monitoring) at the site, to an alternative using, as a principal element, treatment that would reduce the toxicity, mobility, or volume of site waste. An alternative involving treatment as a principal element is one that uses treatment technologies to reduce the principal threats posed by the site. A number of alternatives within the above range should be considered for the site.

In addition, ground-water treatment alternatives for managing migration of contaminants will be developed over a performance range that is defined in terms of a remediation level within the probability range of 10^{-4} to 10^{-7} for maximum lifetime risk and includes different rates of restoration. Where feasible, one alternative will be configured that will restore ground water to a 10^{-6} probability level for maximum lifetime risk within five years.

Alternatives developed will include at least one alternative from each of the following:

1) Alternatives for off-site treatment or disposal, as appropriate;

2) Alternatives which <u>attain</u> applicable and/or relevant Federal public health or environmental standards;

3) Alternatives which <u>exceed</u> applicable and/or relevant public health or environmental standards;

4) Alternatives which do not attain applicable and/or relevant public health or environmental standards but will reduce the likelihood of present or future threat from the hazardous substances. This must include an alternative which closely approaches the level of protection provided by the applicable or relevant standards; and

5) No action.

There may be overlap among the alternatives developed. Furthermore, alternatives outside of these categories may also be developed, such as non-cleanup alternatives (e.g., alternative water supply, relocation).

3.4 Initial Screening Of Alternatives

The alternatives developed in response to Section 3.3 will be screened to eliminate those that are clearly infeasible or inappropriate. This initial screening will be conducted prior to undertaking detailed evaluations of the remaining alternatives.

The purpose of the screening step is to reduce the number of alternatives requiring detailed analysis while preserving a range of options.

This screening is accomplished by considering the public health effects, environmental impacts, technical feasibility, and cost of each alternative relative to the other alternatives. Specifically the factors to be considered in each area are as follows:

1) Public Health Effect: Only those alternatives that satisfy the response objectives and contribute substantially to the protection of public health, welfare, or the environment will be considered further. Source control alternatives will achieve adequate control of source materials. Management of migration alternatives will minimize or mitigate the threat of harm posed by the contaminates at the site to public health, welfare, or the environment;

2) Environmental Effects: Alternatives posing significant adverse environmental effects will be excluded;

3) Technical Feasibility: Technologies that may prove extremely difficult to implement, will not achieve the remedial objectives in a reasonable time period, or will rely upon unproven technology will be modified or eliminated. If there is reasonable belief that an innovative technology offers potential for better treatment performance or implementability, fewer or lesser adverse impacts than other available approaches, or lower costs than demonstrated technologies, then it should be carried through this screening; and

4) Cost: An alternative whose cost far exceeds that of other alternatives which provide similar results will usually be eliminated unless other significant benefits may also be realized. (Note that cost may be compared among treatment alternatives, but not between treatment and non-treatment alternatives) Total costs will include the cost of implementing the alternatives and the cost of operation and maintenance.

The cost screening will be conducted only after the environmental, public health, and technical screenings have been performed.

In some situations the above factors could occasionally result in elimination of alternatives which involve treatment of the source as the principal element. Typically, ground-water actions will be necessary at sites to achieve adequate protection. An explanation of the rationale for eliminating or retaining source treatment options at this point in the process should be included.

3.5 Detailed Evaluation Of Alternatives

The alternatives passing through the initial screening will be analyzed in further detail against a range of factors and compared against one another.

The effectiveness of the alternatives will be assessed, taking into account whether or not (1) an alternative adequately protects human health and the environment and attains Federal and State ARARS, (2) whether or not it significantly and permanently reduces the toxicity, mobility, or volume of hazardous constituents, and (3) whether or not it is technically reliable.

Alternatives will be evaluated against implementability factors, including (1) the technical feasibility and availability of the technologies each alternative would employ, (2) the technical and institutional ability to monitor, maintain, and replace technologies over time, and (3) the administrative feasibility of implementing the alternative.

Finally, the costs of construction and the long-term costs of operating and maintaining the alternatives will be analyzed using present-worth analysis.

Both the short- and long-term effects of each of these factors will be assessed. In considering these items, all of the long-term effectiveness factors cited in SARA Sec. 121 (b) (1) will be addressed. After each alternative has been analyzed against these factors, the remedial options will be compared for their relative strengths and weaknesses.

The detailed evaluation will include, at a minimum, the following specific analyses:

3.5.1 Technical Analysis

The technical analysis will include, as a minimum:

1) A description of appropriate treatment and disposal technologies including the intent of the remedial alternative (e.g., source control or management of migration);

2) Special engineering considerations required to implement the alternatives (e.g., pilot treatment facility, additional studies needed to proceed with final remedial design);

3) Discussions of how the alternative does (or does not) comply with specific requirements of other environmental programs. When an alternative does not comply, a discussion of how the alternative prevents or minimizes the migration of wastes and public health or environmental impacts and a description of special design needs that could be implemented to achieve compliance;

4) Operation, maintenance, and monitoring requirements of the remedy;

5) Identification and review of potential off-site facilities to ensure compliance with applicable RCRA, and other EPA environmental program requirements, both current and proposed. Potential disposal facilities will be evaluated to determine whether off-site management of site wastes could result in a potential for a future release from the disposal facility;

6) Temporary storage requirements;

7) Safety requirements for remedial implementation (including both on-site and off-site health and safety considerations);

8) A description of how the alternatives could be phased into operable units. The description includes a discussion of how various operable units of the total remedy could be implemented individually or in groups, resulting in a significant improvement in the quality of the environment or savings in cost;

9) A description of how the alternates could be segmented into areas to allow implementation of different phases of the alternative;

10) An assessment of local residents' perception of the impact of the alternative;

11) Aspects of the site conditions that the alternative will or will not control;

12) The performance of a remedial alternative based on its effectiveness and useful life. Effectiveness refers to the degree to which an action prevents or minimizes substantial danger to public health, welfare, or the environment. This is usually accomplished via certain functions (i.e., containment, diversion, removal, destruction, or treatment). The effectiveness of an

alternative should be determined either through design specifications or by performance evaluation. The useful life of an alternative is the length of time this level of effectiveness can be maintained. Each alternative will be evaluated in terms of the projected service lives of its component technologies;

13) The reliability of a remedial alternative which includes its operation and maintenance requirements and demonstrated reliability at similar sites. Operation and maintenance (O&M) requirements should be assessed by the availability and cost of necessary labor and materials, and by the frequency and complexity of O&M activities. The demonstrated performance of an alternative should include an estimate of the probability of failure in qualitative or quantitative terms for each component technology and for the complete alternative. Although preference will be given to technologies previously demonstrated under similar site and waste conditions, innovative or developmental technologies should be evaluated as an alternative. Their evaluation will be based on bench scale tests completed during the RI and researchers' laboratory and field tests;

14) An analysis of whether recycle/reuse, waste minimization, waste biodegradation, waste destruction, or other advanced, innovative, or alternative technologies as appropriate to reliably minimize present or future threats to public health, welfare, and the environment;

15) Safety criteria such as the security and freedom from risk, loss, injury, harm, and danger. Each remedial action alternative will be evaluated with regard to safety. Factors to be considered in this evaluation will include short- and long-term threats to the safety of the remedial workers, the community living and working in the site vicinity and the environment and facilities during implementation of the remedial measures; and

16) An analysis of agencies which can provide valuable assistance in the implementation of an alternative. All agencies with which consultations will be needed will thus be listed. A partial list may include the:

- U.S. Dept. of Commerce (NOAA),
- National Park Service,
- Federal Emergency Management Agency,
- Department of Health and Human Services,
- U.S. Army Corps of Engineers,
- U.S. Geological Survey,
- Occupational Safety and Health, Administration, and the
- U.S. Department of Interior (U.S. Fish & Wildlife Service).

3.5.2 Environmental Analysis

The environmental analysis will at a minimum involve performing an Environmental Assessment (EA) for each alternative. The EA should focus on the site problems and pathways of contamination actually addressed by each alternative. The EA for each alternative will include, at a minimum, an evaluation of beneficial effects of the response, adverse effects of the response, and an analysis of measures to mitigate adverse effects. The no-action alternative will be fully evaluated to describe the current site situation and anticipated environmental conditions if no actions are taken. The no-action alternative will serve as the baseline for the analysis.

3.5.3 Institutional Analysis

The institutional analysis will at a minimum involve evaluating each alternative based on its relevant institutional needs. Specifically, regulatory requirements, permits, community relations, and participating agency coordination will be assessed.

3.5.4 Public Health Analysis

The public health analysis will involve evaluating each alternative in terms of the extent to which it will mitigate damage to public health in comparison to the other remedial alternatives.

The public health analysis consists of a baseline site assessment, an exposure assessment, and a comparison of environmental considerations to relevant and applicable standards. First, a baseline site evaluation is conducted where all data on the extent of contamination, contaminant mobility and migration, and types of alternatives are reviewed. The result of the baseline evaluation is the determination of data required to conduct an exposure assessment and the level of detail in this assessment.

Second, an exposure assessment will be conducted. A qualitative exposure assessment is required for source control actions to evaluate the types, amounts, and concentrations of chemicals at the site, their toxic effects, the proximity of target populations, the likelihood of chemical release and migration from the site, and the potential for exposure. A quantitative exposure assessment is conducted for management of migration actions to estimate the frequency, magnitude, and duration of human exposure to toxic chemical contaminants released from a site.

Following the exposure assessment, estimated environmental concentrations of the indicator chemicals selected for the site (if there are a large number of chemicals present) will be compared to applicable or relevant environmental standards such as those found in RCRA regulations, National Interim Primary Drinking Water Standards, Maximum Contaminant Levels, National Ambient Air Quality Standards, EPA and State water quality standards including narrative toxicity standards, as well as EPA criteria for noncarcinogens, carcinogens, and health advisories. When no applicable standard exists, at least one alternative should be aimed at a 10^{-6} lifetime health risk level, and other alternatives in the 10^{-4} to 10^{-7} lifetime health risk level.

3.5.5 Cost Analysis

The cost of each feasible remedial action alternative remaining after initial screening will be evaluated and will include each phase or segment of the alternative and consider cost and non-cost (i.e., loss of natural resources) criteria. The cost of each alternative will be presented as a present worth cost and includes the total cost of implementing the alternative and the annual operating and maintenance cost of implementing the alternative. A distribution of costs over time will also be provided. A table showing the above cost information for each alternative will be included.

In developing detailed cost estimates, the following steps will be performed:

1) Estimation of Costs: Determine capital and annual operating costs for remedial alternatives;

2) Cost Analysis: Using estimated costs, calculate the stream of payments and present worth for each remedial alternative; and

3) Sensitivity Analysis: Evaluate risks and uncertainties in cost estimates; cost estimates should be within +50% and -30% of the actual cost.

3.6 Summary of Alternatives

Using a comparative format, summarize the results of the detailed technical, institutional, public health, and environmental evaluations of each alternative. At a minimum, the following areas will be used to compare alternatives:

1) Present Worth of Total Costs: The net present value of capital, operating, and maintenance costs will be presented;

2) Health Information: For the no-action alternative, a quantitative statement including a range estimate of maximum individual risks will be prepared. If quantification is not possible, a qualitative analysis will be prepared. For source control options, a quantitative risk assessment will not be prepared. For management of migration measures, a quantitative risk assessment including a range estimate of maximum individual risks will be prepared;

3) Environmental Effects: Only the most important effects or impacts will be summarized. Reference will be made to supplemental information arrayed in a separate table, if necessary;

4) Technical Aspects of the Remedial Alternatives: The technical aspects of each remedial alternative relative to the others will be clearly delineated. The information generally will be based on the professional opinion of the engineer regarding the site and the technologies comprising the remedial alternative;

5) Information on the Extent to Which Remedial Alternatives Meet the Technical Requirements and Environmental Standards of Applicable Environmental Regulations: This information will be arrayed so that differences in how remedial alternatives satisfy such standards are readily apparent. The general types of standards that could be applicable at the site include:

   - RCRA design and operating standards; and
   - EPA and State drinking water standards and criteria including narrative toxicity standards;

6) Information on Community Effects: The type of information that will be provided is the extent to which implementation of a remedial alternative disrupts the community (e.g., traffic, temporary health risks, and relocation); and

7) Other Factors: This category of information will include such things as institutional factors that may inhibit implementing a remedial alternative and any other site-specific factors identified in the course of the detailed analysis that may influence which alternative is eventually selected.

3.7 Recommended Remedial Action

Based on discussions with EPA and SCDHEC, and the results of the detail evaluation, a recommendation on which remedial action alternative is most cost-effective at the site will be made.

3.8 Preparation Of Draft Feasibility Study Report

Prepare a report which describes the feasibility study and presents the results of the FS tasks. The report format should follow the format shown on Table 5. The executive summary of the report will be of sufficient detail that it can be used to present the results of the RI/FS to the public.

3.9 Final Feasibility Study Report

Incorporate comments received from EPA, the State, and public, as compiled by EPA, and make the necessary revisions of the Draft Feasibility Study Report.

TABLE 5

FEASIBILITY STUDY REPORT FORMAT

Executive Summary

1.0 Introduction

- 1.1 Site background information
- 1.2 Nature and extent of problems
- 1.3 Objectives of remedial action

2.0 Screening of Remedial Action Technologies

- 2.1 Technical criteria
- 2.2 Remedial action alternatives developed
- 2.3 Environmental and public health criteria
- 2.4 Other screening criteria
- 2.5 Cost criteria

3.0 Remedial Action Alternatives

- 3.1 Alternative 1 (No Action)
- 3.2 Alternative 2
- .
- .
- .
- 3.N Alternative N

4.0 Analysis of Remedial Action Alternatives

- 4.1 Noncost criteria analysis
  - 4.1.1 Technical feasibility
  - 4.1.2 Environmental evaluation
  - 4.1.3 Institutional requirements
  - 4.1.4 Public health evaluation
- 4.2 Cost analysis

5.0 Summary of Alternatives

6.0 Recommended Remedial Action (optional)

References

Appendices

APPENDIX A

REMEDIAL TECHNOLOGIES

A. <u>Air Pollution Controls</u>

- Capping
  - Synthetic membranes
  - Clay
  - Asphalt
  - Multimedia cap
  - Concrete
  - Chemical sealants/stabilizers
- Dust Control Measures
  - Polymers
  - Water

B. <u>Surface Water Controls</u>

- Capping (see A.)
- Grading
  - Scarification
  - Tracking
  - Contour furrowing
- Revegetation
  - Grasses
  - Legumes
  - Shrubs
  - Trees, conifers
  - Trees, hardwoods
- Diversion and Collection Systems
  - Dikes and berms
  - Ditches and trenches
  - Terraces and benches
  - Chutes and downpipes
  - Seepage basins
  - Sedimentation basins and ponds

(continued)

- Levees
- Addition of freeboard
- Floodwalls

C. <u>Leachate and Ground Water Controls</u>

- Capping (see A.)

- Containment barriers

  Function options

  - Downgradient placement
  - Upgradient placement
  - Circumferential placement

  Material and construction options (vertical barriers)

  - Soil-bentonite slurry wall
  - Cement-bentonite slurry wall
  - Vibrating beam
  - Grout curtains
  - Steel sheet piling

  Horizontal barriers (bottom sealing)

  - Block displacement
  - Grout injection

- Ground water pumping (generally used with capping and treatment)

  Function options

  - Extraction and injection
  - Extraction alone
  - Injection alone

  Equipment and Material Options

  - Well points
  - Deep wells

(continued)

- Suction wells
- Ejector wells

- Subsurface Collection Drains
  - French drains
  - Tile drains
  - Pipe drains (dual media drains)

D. <u>Gas Migration Controls</u> (generally used with treatment)

- Capping (gas barriers) (see A.)
- Gas collection and/or recovery
  - Passive pipe vents
  - Passive trench vents
  - Active gas collection systems

E. <u>Excavation and Removal of Waste and Soil</u>

- Excavation and removal
  - Backhoe
  - Cranes and attachments
  - Front end loaders
  - Scrapers
  - Pumps
  - Industrial vacuums
  - Drum grapplers
  - Forklifts and attachments
- Grading (see B.)
- Capping (see A.)
- Revegetation (see B.)

F. <u>Removal and Containment of Contaminated Sediments</u>

- Sediment removal

(continued)

Mechanical dredging

- Clamshell
- Dragline
- Backhoe

Hydraulic dredging

- Plain suction
- Cutterhead
- Dustpan

Pneumatic dredging

- Airlift
- Pneuma
- Oozer

- Sediment turbidity controls and containment
  - Curtain barriers
  - Coffer dams
  - Pneumatic barriers
  - Capping

G. <u>In Situ Treatment</u>

- Hydrolysis
- Oxidation
- Reduction
- Soil aeration
- Solvent flushing
- Neutralization
- Polymerization
- Sulfide precipitation
- Bioreclamation
- Permeable treatment beds
- Chemical dechlorination

(continued)

APPENDIX A (continued)

H. Direct Waste Treatment

- Incineration

  - Rotary kiln
  - Fluidized bed
  - Multiple hearth
  - Liquid injection
  - Molten salt
  - High temperature fluid wall
  - Plasma arc pyrolysis
  - Cement kiln
  - Pyrolysis/starved combustion
  - Wet air oxidation
  - Industrial boiler or furnace

- Gaseous waste treatment

  - Activated carbon
  - Flares
  - Afterburners

- Treatment of aqueous and liquid waste streams

  Biological treatment

  - Activated sludge
  - Trickling filters
  - Aerated lagoons
  - Waste stabilization ponds
  - Rotating biological disks
  - Fluidized bed bioreactors

  Chemical treatment

  - Neutralization
  - Precipitation
  - Oxidation
  - Hydrolysis
  - Reduction
  - Chemical dechlorination
  - Ultraviolet/ozonation

(continued)

Physical treatment

- Flow equalization
- Flocculation
- Sedimentation
- Activated carbon
- Kleensorb
- Ion exchange
- Reverse osmosis
- Liquid-liquid extraction
- Oil-water separator
- Steam distillation
- Air stripping
- Steam stripping
- Filtration
- Dissolved air flotation

Discharge to a publicly owned treatment works

- Solids handling and treatment

Dewatering

- Screens, hydraulic classifiers, scalpers
- Centrifuges
- Gravity thickening
- Flocculation, sedimentation
- Belt filter presses
- Filter presses
- Drying or dewatering beds
- Vacuum-assisted drying beds

Treatment

- Neutralization
- Solvent
- Oxidation
- Reduction
- Composting

- Solidification, stabilization, or fixation

  - Cement-based

(continued)

- Lime-based
- Thermoplastic
- Organic polymer
- Self-cementing techniques
- Surface encapsulation
- Classification
- Solidification (i.e., to fly ash, polymer, sawdust)

I. Land Disposal Storage

- Landfills
- Surface impoundments
- Land application
- Waste piles
- Deep well injection
- Temporary storage

J. Contaminated Water Supplies and Sewer Lines

- In situ cleaning
- Removal and replacement
- Alternative drinking water supplies
  - Cisterns or tanks
  - Deeper or upgradient wells
  - Municipal water systems
  - Relocation of intake
- Individual treatment units